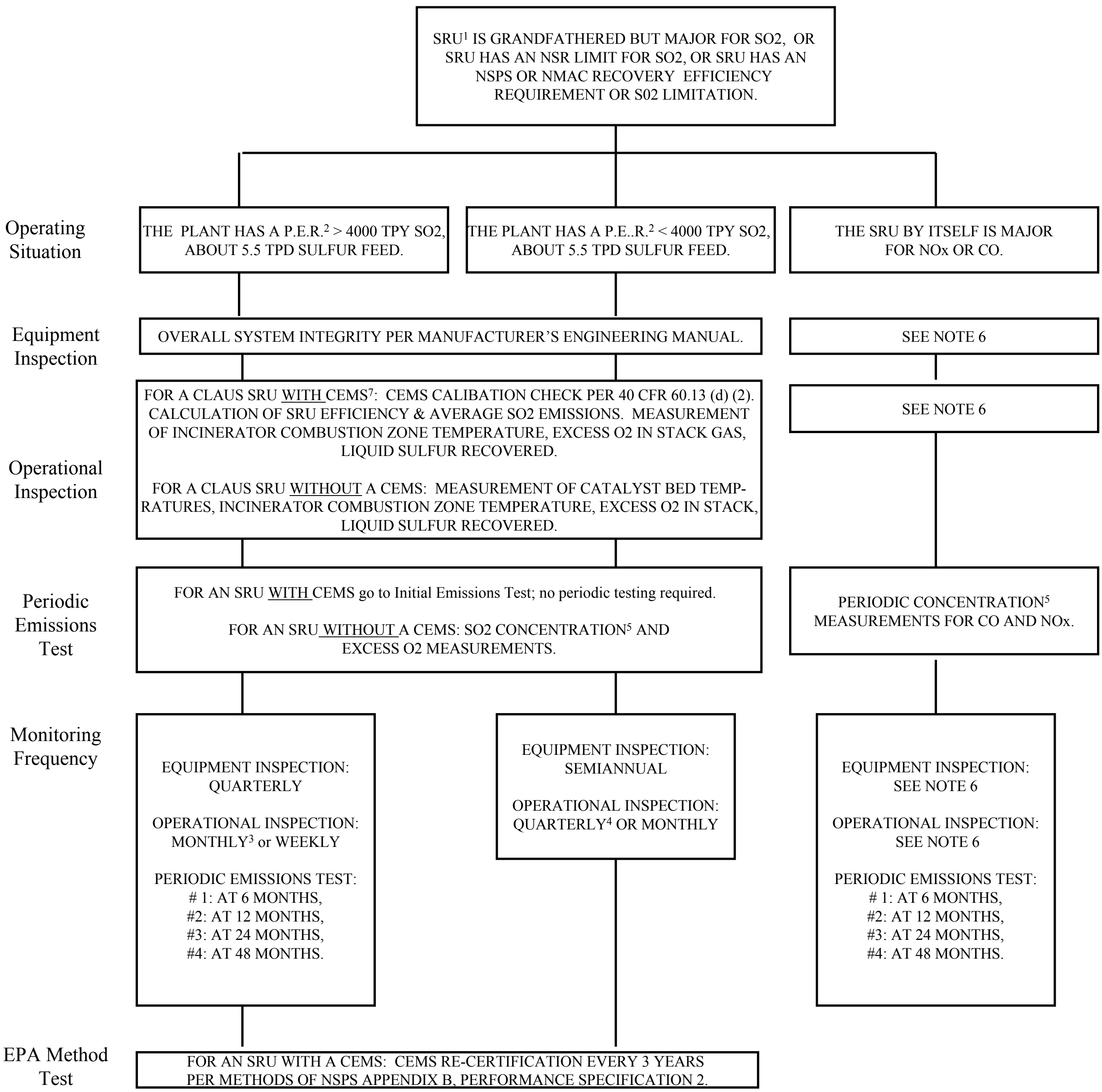
MONITORING FOR A CLAUS SRU AT A TITLE V SOURCE
VERSION 10/01/2003, PG.1



Notes

1. SRU = Sulfur Recovery Unit
2. Potential Emissions Rate (P.E.R.) of the plant means the emission rate at the plant's maximum capacity in the absence of the SRU and in the absence of any federally enforceable physical limitation on the plant capacity. In the latter respect, this definition differs from the definition in 20 NMAC 2.72, S107.V.

3. Weekly for an SRU without an air demand analyzer.

4. Monthly for an SRU without an air demand analyzer.

MONITORING FOR A CLAUS SRU (CONTINUED)
VERSION 10/01/03, PG. 2

SRU[1] IS GRANDFATHERED BUT MAJOR FOR SO2, OR SRU[1] HAS AN NSR LIMIT OFR SO2,, OR SRU HAS AN NSPS OR NMAC RECOVERY EFFICIENCY REQUIREMENT OR SO2 LIMITATION.

Operating Situation	THE SRU IS REGULATED BY NSPS SUBPART J. (PETROLEUM REFINERY)	THE SRU IS REGULATED BY NSPS SUBPART LLL. (NATURAL GAS PLANT)	THE PLANT /SRU IS REGULATED BY 20 NMAC 2.35, 2.36. OR 2.39.	THE SRU IS GRANDFATHERED OR HAS NOT HAS AN EPA METHOD TEST WITHIN 10 YEARS OF PERMIT ISSUE.
Equipment Inspection	SEE NOTE 6	SEE NOTE 6	SEE NOTE 6	SEE NOTE 6
Operational Inspection	SEE NOTE 6	MEAS, OF ACCUMULATED SULFUR, ACID GAS FLOW CONC., SULFUR FEED RATE, RECOVERY EFFICIENCY, & COMBUST. ZONE TEMPERATURE PER 40 CFR 60.642 (b) & 60.646.	SULFUR CONTENT OF FEEDSTOCK, FUELS, PRODUCTS, AND INLET/ OUTLET STREAMS TO SRU, WEIGHT OF RECOVERED SULFUR.	SEE NOTE 6
Periodic Emissions Test	CEMS[7] REQUIRED PER 40 CFR 60.105 (a) (5).	SEE NOTE 6	SEE NOTE 6	SEE NOTE 6
Monitoring Frequency	DAILY CEMS CALIBRATION PER 40 CFR 60.13 (d) (1).	DAILY OPERATIONAL INSPECTION PER 40 CFR 60.642 (b) AND 60.646.	RANGE IS FROM THRICE WEEKLY MEAS. OF SULFUR CONTENT OF FEEDSTOCK TO QUARTERLY MEAS. OF INLET/ OUTLET STREAMS TO SRU PER 20 NMAC 2.35 S 112, 2.36 S113, OR 2.39 S114.	SEE NOTE 6
EPA Method Test	CEMS PERFORMANCE EVALUATION PER 40 CFR 60.105 (a) (5), (6), OR (7). STACK TEST PER 40 CFR 60.106 (a) AND (f).	RECOVERY EFFICIENCY PER 40 CFR 60.642(a), 60.643, AND 60.644.		FULL STACK EMISSION TEST

5. Periodic <u>mass</u> emissions measurement not recommended due to difficulty of measuring incinerator stack flow.

6. See appropriate monitoring in another category on this page or previous page if that category also pertains to the plant or to the SRU.

7. CEMS = Continuous emissions monitoring systems.

PERIODIC MONITORING GUIDELINES
SULFUR RECOVERY UNITS (SRUs)
LOCATED AT NEW MEXICO TITLE V SOURCES

Permit Language

3.4 Emissions Monitoring and Testing Requirements. These conditions are included pursuant to Subsection C of 20.2.70.302 NMAC **{and NSR permit no. XXX and NSPS Subpart YY.}**

3.4.1 The following table lists emissions units and their applicable requirements and required monitoring. Descriptions of required monitoring follow the table:

Required Monitoring for Emissions Units (example):

Emission Unit Number	Parameters to Monitor	To Comply With	Monitoring Required	Monitoring Frequency
Unit x (SRU)	Overall System Integrity	Emissions Limits specified in Sect 3.2	Equipment Inspection	Monthly
	CEMS calibration	Emissions Limits specified in Sect 3.2	Per NSPS Subpart LLL	Monthly
	Sulfur recovery efficiency	NSPS Subpart LLL	Per NSPS Subpart LLL	Monthly

{Apply the following sections as required by the flow charts.}

(NOTE: It is the responsibility of the permit engineer to ensure proper integration of the monitoring and testing requirements for an SRU subject to multiple, often conflicting, requirements: NSR permit, 20 NMAC regulations, NSPS Subpart LLL or J, etc. For a plant with a recent NSR permit, most of the monitoring and testing requirements will already have been put in practice by the permittee and the permit engineer for the most part will only need to transfer those requirements to the operating permit.}

3.4.1.1 Equipment Inspection
The sulfur recovery unit (SRU) as listed in Sect. 3.4.1 shall undergo periodic equipment inspections at the frequency indicated in the table by the methods described below.

The permittee shall inspect the overall integrity of the SRU in accordance with the manufacturer's engineering manual and recommendations.

3.4.1.2 Operational Inspection
The SRU listed in Sect. 3.4.1 shall undergo periodic operational inspections at the frequency indicated in the table by the methods described below.

{Add the following language for <u>all</u> plants with a Claus SRU. If there is an NSR permit carefully analyze for redundancy}

3.4.1.2.1 The permittee shall comply with the sulfur measurement requirements of 20 NMAC **{2.35 Sect. 112.A for gas plants, 2.36 Sect. 113.A for petroleum refineries, 2.39 Sect. 114.A for stand alone SRUs.}**

In addition, the permittee shall measure and record the following SRU variables:

a) The temperature of all catalyst beds (upper, middle, and lower zones) and of the condensers; **{delete this condition, a), if equipped with CEMS}**

b) The temperature of the incinerator combustion zone;

c) The excess O_2 level in the incinerator flue gas;

d) The acid gas flow rate and concentration of H_2S;

e) A running tally of the accumulated elemental sulfur.

The instruments (other than an SO_2 CEMS) used to measure sulfur concentrations of the gas streams into the SRU shall be calibrated and maintained at a frequency and method specified by the manufacturer, but no less frequently than quarterly.

{Use the following language for an SRU subject to NSPS Subpart LLL.}

3.4.1.2.2 The permittee shall carry out the daily operational inspection required by NSPS Subpart LLL, 40 CFR 60.642(b) and 60.646.

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OPERATIONAL INSPECTION LANGUAGE FOR AN SRU WITH CEMS

3.4.1.2.3 In accordance with **{NSR permit condition xx or NSPS Subpart J}** the SRU shall be equipped with a properly operating continuous emissions monitoring system (CEMS). **{Here you may want to borrow appropriate language from the NSR permit.}**

The CEMS shall be calibrated daily in accordance with NSPS Subpart A, 40 CFR 60.13(d)(1).

{If the SRU has no CEMS but this operating permit will require one, use the following language or refer to a recent NSR permit.}

3.4.1.2.4 A continuous SO_2 CEMS (concentration monitor and flowmeter) shall be installed on the incinerator stack of the SRU. The monitor shall complete a minimum of one cycle of operation (sampling, analyzing and data recording) for each successive 15 minute period or less. One-hour averages shall be computed from four or more data points equally spaced over each one-hour period. The data from the SO_2 stack gas monitor and flowmeter shall be analyzed on an hourly basis for SO_2 concentration and volume flow rate.

The minimum data capture for the CEMS shall be 95%. Only those times when both the SO_2 concentration monitor and the stack gas flowmeter are operating simultaneously shall count towards the data capture requirement. Periods when the SRU is not operational are excluded from the data capture calculation.

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3.4.1.3 Periodic Emissions Test
The SRU listed in Sect. 3.4.1 shall undergo periodic emissions tests at the frequency indicated in the table by the methods described below.

{Use the following language for a periodic emission test for a Claus SRU without a CEMS. An SRU with an SO_2 CEMS requires no periodic emissions testing unless the SRU is by itself major for NOx or CO. If the SRU is by itself major for either NOx or CO, adjust the following language to also require NOx and CO concentration measurements even when the incinerator has an SO_2 CEM.}

3.4.1.3.1 The SO_2 **{and NOx and CO}** concentration of the incinerator flue gas shall be measured. The measurement may be carried out using a portable flue gas analyzer using the procedures in the most current version of the Bureau's Standard Operating Procedure: Use of Portable Analyzers in Performance Tests. The permittee need only observe those sections relative to sample conditioning, analyzer range and sensitivity, response time, and calibration. The test may also be carried out using any effective procedure approved in advance by the Department. Emissions shall be expressed in parts per million.

3.4.1.3.2 Each test shall be carried out while the SRU is operating at a load representative of the load during the relevant time period. Periodic emissions tests shall be conducted at the intervals in the following schedule:

First test: Six (6) months from permit issuance;

Second test: Twelve (12) months from permit issuance;

Third test: Twenty four (24) months from permit issuance;

Fourth test: Forty eight (48) months from permit issuance;

All subsequent testing shall follow at twenty four (24) month intervals. However, the test schedule is contingent on maintaining test data that indicates compliance. If any test indicates non-compliance, the periodic emissions test sequence shall revert to the beginning of the above schedule starting with the date of the most recent test.

{Use the language below to require an EPA Methods test of an SRU that has not had a stack test in the ten years previous to permit issuance.}

3.4.1.4 EPA Methods Test[jwk1]
The following analysis procedures and test methods shall be performed as part of the EPA Methods test requirement for the SRU listed in Sect. 3.4.1.

3.4.1.4.1 A mass emissions test for SO_2, CO, and NOx shall be conducted on the SRU in accordance with EPA Methods 1 through 4, Method 6 (SO_2), Method 7 (NO_x), and Method 10 (CO) contained in 40 CFR Part 60, Appendix A, and with the requirements of Subpart A, General Provisions, Sect. 60.8(f). The results of the test for nitrogen oxides shall be expressed as nitrogen dioxide (NO_2) using a molecular weight of 46 lb/lb-mole in all calculations.

3.4.1.4.2 The SRUs sulfur recovery efficiency and the incinerator's sulfur combustion efficiency shall be determined in accordance with the appropriate subsections of NSPS Subpart LLL, 40 CFR 60.644.

{For SRUs not subject to NSPS Subpart J or LLL, and that require an EPA Methods Test, use the following paragraph to replace the one above.}

The SRUs sulfur recovery efficiency and the incinerator's sulfur combustion efficiency shall be determined in accordance with the attached Standard Operating Procedure: Sulfur Recovery Unit Performance Testing.

3.4.1.4.3 The permittee shall notify the Department at least thirty (30) days prior to the test date and allow a representative of the Department to be present at the test. The permittee shall arrange a pre-test meeting with the Department at least thirty (30) days prior to the test date and shall observe the following pre-testing and testing procedures:

a) The test protocol and test report shall conform to the standard format specified by the Department as described in Standard Operating Procedure: Contents of Stack Test Protocols. The most current version of the format may be obtained from the Enforcement Section of the Air Quality Bureau.

b) The permittee shall provide (a) sampling ports adequate for the test methods applicable to the facility, (b) safe sampling platforms, (c) safe access to sampling platforms and (d) utilities for sampling and testing equipment.

The stack shall be of sufficient height and diameter so that a representative test of the emissions can be performed in accordance with EPA Method 1.

c) During compliance tests the following variables shall be measured and recorded and included with the test report:

The SRUs bed temperatures (top, middle, and bottom), condenser temperatures, incinerator combustion zone temperature, flow and concentration of acid gas feedstock to SRU, and amount of elemental sulfur recovered.

d) Where necessary to prevent cyclonic flow in the stack, flow straighteners shall be installed.

e) The tests shall be carried out at 90% or greater of the SRUs full operating capacity and at other operating loads as may be specified by the Department at the time of the test or pre-test meeting.

{Add the following section for an SRU with a CEMS.}

3.4.1.5 CEMS recertification

The CEMS on the SRU incinerator shall be recertified every three years according to the methods in NSPS Appendix B, 40 CFR 60. The first recertification shall take place on or before **{select a date by adding three years to the most recent certification.}** The permittee shall submit a test protocol at least 30 days prior to the anticipated date of the certification. **{Also feel free to borrow certification language from the NSR permit.}**

3.4.2 When requested by the Department, the permittee shall provide schedules of testing and monitoring activities.

3.4.3 Unless otherwise identified in this permit, all periodic monitoring requirements listed in Sect. 3.4.1 are effective 120 days after the date of permit issuance.

RECORDKEEPING

4.1.2 The permittee shall maintain records of all SRU inspections and tests required by this permit and records of any adjustments, repairs, or replacements needed to bring the SRU into compliance with the terms of this permit. All records shall show the date of inspection and the name of the person(s) who carried out the inspection.

If the permittee keeps records more frequently that the minimum frequency required by this permit, the permittee shall also keep these records for Department inspection.

The permittee shall also follow the record keeping requirements listed below and shall keep records of any other information the Department may request to allow the Department to verify the accuracy of the monitoring or the proper operation of the SRU.

{Select from the following list as necessary:}

4.1.2.1 The permittee shall comply with the sulfur record keeping requirements of Subsection X of 20.X.XX.XX NMAC **{2.35 Sect. 112.A for gas plants, 2.36 Sect. 113.A for petroleum refineries, 2.39 Sect. 114.A for standalone SRUs.}**

4.1.2.2 Equipment Inspections
Records of equipment inspections shall describe the overall physical condition of the SRU. The permittee shall maintain records of all service and maintenance performed on the SRU, and include a description of the problem requiring the maintenance or repair.

4.1.2.3 Operational Inspections
Records of operational inspections shall show the values of all parameters that are required to be recorded by Sect. 3.4.1.2.

4.1.2.4 Periodic Mass Emissions Tests
Records of periodic emissions tests on the incinerator shall include all original data and records showing concentrations of relevant species or data and records needed to compute such concentrations.

The permittee shall maintain records showing calibration results on any instrument or apparatus used to determine pollutant concentration species, process stream flows, or temperatures.

{If the SRU is subject to NSPS Subpart J or Subpart LLL, add the following language.}

4.1.2.5 The permittee shall comply with the record keeping requirements of 40 CFR 60.7 regarding any startup, shutdown, or malfunction of the SRU or the incinerator, or **{if the SRU has a CEMS}** any period when the CEMS required by the subpart is inoperative.

{If the SRU has a CEM, add the following language.}

4.1.2.6 The permittee shall maintain records of all calibrations carried out on the SO_2 CEMS. The record shall show the date of calibration, and calibration gas data (concentration, gas supplier name and address, mixture serial number and expiration date).

The permittee shall maintain records of all service and maintenance performed on the CEMS, including a description of the problem requiring the maintenance or repair.

5.0 REPORTING

5.1 Monitoring Reports
The monitoring reports shall contain the information requested in the sections below. In addition, all instances of deviations from permit requirements, including those that occur during emergencies, shall be clearly identified in the required reports.

Conditions of Sect. 5.1 are included pursuant to Subsection E of 20.2.70.302 NMAC.

{Select from the following list as necessary:}

5.1.1 Equipment and/or Operational Inspections
Reports of equipment and/or operational inspections shall briefly summarize in chronological order the results of all SRU inspections noting any adjustments needed to bring the SRU into compliance with permit conditions.

5.1.2 Periodic Emissions Tests
Reports of periodic emissions tests shall summarize in tabular form for each test the SO_2 **{and NOx/CO, if applicable}** concentrations expressed in parts per million. The table shall include the incinerator combustion zone temperature, the level of excess air, and the SRU bed temperatures.

5.1.3 EPA Methods Test.
The report of the initial or subsequent emissions tests shall conform to the standard format specified by the Department, Standard Operating Procedure: Contents of Stack Test Reports.

{If in addition the SRU is required by NSPS Subpart J to have a CEM, add the following language.}

5.1.4 The SO_2 CEM shall comply with the reporting requirements of 40 CFR 60.7 regarding submission of excess emissions reports, monitoring reports, and/or summary reports.

5.2 Reporting Frequency.
Reports of all required monitoring activities for this facility, except those reports required by an NSPS, shall be submitted to the Department according to the schedule indicated below.

{Consult with the Enforcement and the Compliance Sections for the desired frequency of monitoring.}

Reports required by NSPS **{Subpart J or Subpart LLL, as applicable}** shall be submitted at the frequency required by the appropriate NSPS subpart.

5.4 Emissions Test Notification
Protocols for emissions tests shall be submitted to the Department at least four (4) weeks prior to the scheduled test date with content according to the Department's Standard Operating Procedure for Contents of Stack Test Protocols. If information remains the same as previously submitted protocols, test protocols shall reflect that fact and show only new information. This condition is pursuant to Subsection E of 20.2.70.302 NMAC.

BACKGROUND INFORMATION

(Not for inclusion in permit)

In New Mexico, Claus sulfur recovery units (SRUs) are found almost exclusively at oil and gas plants. There are roughly fifteen Claus plants in New Mexico, one located at a petroleum refinery, the remainder at natural gas processing plants.

The presence of an SRU almost automatically ensures that a plant is major for SO_2 under Title V. The minimum SO_2 emission rate for a Claus plant is about 150 TPY. (This figure is based on the lowest practical feed to a Claus SRU that is about 5 TPD as sulfur and a sulfur recovery rate of 95%, the highest efficiency typically found at a properly operating SRU unless an expensive fourth cleanup stage has been added.) Claus plants in New Mexico treat up to 50 tons per day (TPD) of H_2S, but 20 TPD is typical.

SRUs in New Mexico are regulated under 20.2.35 NMAC (Natural Gas Plants), 2.36 (Petroleum Refineries), or 2.39 (Standalone SRUs). These regulations impose a minimum sulfur recovery efficiency around 90% depending on the size and age of the plant. Only 20.2.39 NMAC imposes a recovery efficiency on the SRU. The other two regulations (20.2.35 and 20.2.36 NMAC) impose a limit on the plant as a whole rather than on the SRU. However, practically speaking, a limitation on the overall sulfur recovery rate of the plant is the same as the sulfur recovery limit on the SRU. The recovery efficiency imposed by 20 NMAC regulations are not federally enforceable since the oil/gas regulations are not part of the state implementation plan (SIP).

SRUs at natural gas plants are also regulated by NSPS Subpart LLL (40 CFR 60) if the plant has undergone a sulfur-related modification. Subpart LLL imposes a sliding scale recovery efficiency depending primarily on the H2S concentration of the acid gas and the sulfur feed rate. Only two or three SRUs in New Mexico are regulated under Subpart LLL but this situation could change as plants modify or reconstruct. NSPS Subpart J applies to certain SRUs at petroleum refineries.

Operating Principle of a Claus SRU. The purpose of a Claus plant is to convert a gaseous waste stream of H_2S, known as acid gas, into liquid sulfur. The liquid sulfur is collected in a holding tank and shipped by rail or truck where it is either used to produce sulfuric acid or is cast into solid blocks and warehoused or landfilled.

In spite of its large, complicated appearance, a Claus plant is built around the following simple gas phase exothermic chemical equilibrium:

$$2\ H_2S + SO_2 \overset{\text{Catalyst}}{\rightleftharpoons} 2\ H_2O + 3\ S \text{ (condenses)}$$

The produced sulfur condenses out of the gas phase into a liquid and is stored in a holding tank. In accordance with Le Chatelier's principle, the steady condensation of the sulfur out of the gas phase drives the equilibrium to the right, ensuring the continual consumption of H_2S.

The first step in a Claus process is to oxidize one third of the H_2S molecules to SO_2 in order to produce the requisite 2:1 stoichiometric ratio in accordance with the left hand side of the chemical equation. A large fraction of the elemental sulfur produced at a Claus plant occurs in the post-combustion zone of the oxidizer as the gases cool below the sulfur boiling point.

A Claus plant contains two or three catalyst beds in series. The purpose of each bed is to shorten the time to equilibrium. The first catalyst bed takes the unreacted portion of the H_2S/SO_2 emerging from the oxidizer and "squeezes" some more sulfur out of the gas stream. By the time the gas stream reaches the third bed, if there is one, very small amounts of elemental sulfur are produced.

The sulfur conversion efficiency of a Claus SRU depends strongly on the H_2S concentration of the acid gas. Typically, a 3-bed Claus which processes acid gas consisting of 30% H_2S will have a recovery efficiency in the range 90% to 94%. Claus plants at refineries where the tail gas is around 90% H_2S have sulfur recovery rates in the range 96% to 98%. SRUs treating acid containing less than about 20% H_2S usually resort to some recirculation schemes to keep the efficiency high.

The gas emerging from the last bed, known as tail gas, contains unrecovered sulfur species (usually SO_2 or H_2S, CS_2, COS, mercaptans), water vapor, sulfur vapor, CO, large amounts of CO_2, and enormous amounts of free nitrogen, and some NOx. The tail gas is incinerated to prevent the emission of reduced sulfur compounds. To effect combustion of the tail gas, which by itself will not burn due to the large amount of free N_2 and CO_2, natural gas and excess air are introduced into the incinerator. H_2S to SO_2 conversion efficiency is typically >98% provided the combustion zone temperature is above 1050^{o}F and there is at least 1% excess air.

Feedback Control. Modern SRUs contain a tail gas analyzer (also known as an air demand analyzer) that measures the H_2S to SO_2 ratio in the tail gas. The analyzer generates a feedback signal proportional to the H_2S/SO_2 ratio and this signal is used to control an air demand valve in the oxidizer that ensures that just enough air enters the oxidizer to produce a 2:1 H_2S/SO_2 ratio. Careful control of the air feed must be exercised since no oxygen can be allowed to enter the catalyst beds. Tail gas analyzers work adequately only when the acid gas is stable in flow rate and concentration. SRUs without a tail gas analyzer cannot be relied upon to maintain an optimum sulfur conversion efficiency over a time span longer than about a day.

The most recent SRUs also include a "feed forward" feedback loop that squeezes out an extra percent or two of efficiency from the SRU. The feed forward loop stabilizes the SRUs operation by anticipating changes in acid gas flow and concentration, a function that the tail gas analyzer is unable to carry out.

Catalyst Maintenance and Operation. An active catalyst is essential to keeping the SRUs recovery efficiency above 90%. Catalyst life ranges from one year in the worst case to five or more years in the best case. Catalyst poisoning seems to occur primarily when hydrocarbon carryover in the acid gas stream is high. A fire in the catalyst bed usually results in the rapid and complete inactivation of the catalyst.

Replacing the catalyst is a cumbersome process that requires the complete shutdown of the SRU for periods of about 36 hours to several days. During this time, plants customarily reduce the raw gas processing rate and flare all the acid gas, releasing from 10 to 20 TPD of SO_2 into the atmosphere. Plants that process casinghead gas (i.e. gas derived from oil wells) are very reluctant to shut in production due to the well-established risk of reduced gas production after the well is reopened.

Each catalyst bed must be operated at a predetermined and steady temperature to assure optimal operation of the sulfur recover process. Temperature must be low enough to drive the equilibrium to sulfur formation but not so low that the kinetic rate is materially decreased. It is critical to maintain the final bed at a significantly lower temperature than the previous beds to promote sulfur condensation.

Character of Emissions

Emissions of concern from Claus SRUs consist of SO_2, CO, reduced sulfur compounds, and some NOx. Emissions of particulates and VOCs tend to be negligible. Particulates in the form of sulfuric acid mist occasionally occur in the form of a detached hazy plume from the incinerator but such situations are uncommon.

Air Toxics from SRUs
The initial combustion of one third of the inlet H_2S to SO_2 creates at least two air toxics from the federal Title III list: carbon disulfide (CS_2) and carbonyl sulfide (COS) especially in those cases where the acid gas is very high in CO_2.
Monitoring Protocol - Sulfur Recovery Units
March 31, 1998 - Page 13

Normally, these substances are not emitted from the SRU. They are hydrolized to H_2S then converted to elemental sulfur in the first catalyst bed. Any surviving COS or CS_2 usually is oxidized in the incinerator with an efficiency around 98%. However, improper operation of the incinerator, for example insufficient oxygen or too low a temperature, can result in substantial emissions of COS and CS_2.

Compliance Determination. As explained above, sulfur plants need to comply either with a minimum sulfur recovery efficiency imposed
by state or federal regulations, a maximum SO_2 emission limit imposed by the permit, or both.

Until the advent of continuous emission monitors (CEMs), compliance with both sulfur recovery efficiency and SO_2 emission limits was problematic. It was not unusual to find a gas plant reporting a sulfur recovery efficiency above 100%.

Before CEMS, the measurement of recovery efficiency relied on the amount of elemental sulfur recovered and the amount of sulfur entering the plant from the acid gas stream. Although these would seem like straightforward measurements, there were too many uncertainties in the H_2S concentration measurements and/or flow rate of the acid gas to obtain reliable estimates of the sulfur feed rate. Many plants were unable to match the amount of sulfur entering the SRU with the amount of sulfur entering the plant in the field gas, even though almost all the sulfur entering the plant went to the SRU!

When CEMs came of age in the late 1980s, the measurement of sulfur recovery and of the SO_2 emission rate from the incinerator took on a new meaning. CEMs made it possible to measure SO_2 emission rates to a reliability of $\pm$5% when proper calibration procedures were specified in the permit and to measure the sulfur recovery efficiency to a reliability of $\pm$2%.

Unfortunately CEMs are expensive to purchase and install, are costly to maintain, and require daily calibration. Purchase and installation costs range from $100K to $200K, depending on the specifics of the plant. Maintenance costs run around $5,000 to $10,000 per year, primarily for calibration, maintenance, and repair. Finally, the plant must train a skilled operator to maintain and operate the unit.

A portable emissions analyzer is important but of limited value as a field tool to determine compliance. Since flue gas flow velocity measurements on the incinerator are very difficult to carry out accurately due to the extremely low gas velocity and density, no mass emission data is obtainable. The SO_2 concentration obtained by the portable analyzer is however a good indicator of compliance especially if the results of a recent stack test is available. The SO_2 concentration can also be tracked over a long period of time to determine if there is an upward trend that might indicate non-compliance. A portable analyzer with an O_2 sensor would also be useful to ensure that enough oxygen is present in the incinerator to oxidize reduced sulfur compounds.

JUSTIFICATION
(Not for inclusion in permit)

EQUIPMENT INSPECTION. SRUs should be inspected periodically for the unit's overall integrity.

The presence of the acidic gases H_2S and SO_2 creates corrosion problems with the SRU. The operator needs to make weekly checks for the presence of corrosion that would allow atmospheric leaks of
H_2S and SO_2.

OPERATIONAL INSPECTION. SRUs are temperamental and must be watched carefully, especially if the acid gas flow rate or composition are not steady. An SO_2 CEM on the incinerator stack is the most valuable monitoring device for proper operation of an SRU. High SO_2 emission rates are immediately indicative of improper SRU operation and would prompt an alert operator to examine the cause of the malfunction.

An SRU without an SO_2 CEM could conceivably operate at a low conversion rate for many days without any obvious indication of malfunction. An operator might notice a decreased sulfur production rate or might notice an irregularity in the temperature profile across the catalyst bed. But if these parameters are not carefully monitored and interpreted by a skilled operator, an SRU might operate out of compliance for a long time before the operator takes corrective measures.

Therefore, an SRU without an SO_2 CEMS should be monitored frequently. Bed temperature profiles should be recorded and the weekly recovery efficiency should be determined from acid gas flow and concentration data and the amount of recovered sulfur. (Daily recovery checks would be desirable but are not recommended due to the difficulty in accurately measuring recovered sulfur on that short a time scale. Daily recovery values can drift from 85% recovery on one day to 115% the next due solely to measurement error.)

All SRUs, even those with a CEMS, should have checks of parameters that are critical for obtaining a high incinerator combustion efficiency. These parameters are the temperature of the combustion zone and the amount of excess air. When the excess oxygen drops below 1%, there is the danger that reduced sulfur compounds are being emitted in copious amounts into the atmosphere. Although O_2 checks using a portable analyzer are essential to determine the level of excess air, the operator should make spot checks of the incinerator's air louvers to ensure that these are sufficiently open to let in the necessary amount of combustion air.

FLUE GAS SO_2 AND O_2 CONCENTRATION-ONLY MEASUREMENTS USING A PORTABLE ANALYZER. To ensure proper operation of the SRU, the flue gas should be monitored at least weekly for SO_2 and O_2 using a portable combustion analyzer or its equivalent. Procedures should follow the methods described in the Bureau's Standard Operating Procedure: Use of Portable Analyzers in Performance Tests. Since only a concentration must be measured, the permittee need only observe those sections of the SOP relative to sample conditioning, analyzer range and sensitivity, response time, and calibration.

Periodic checks of the incinerator's combustion efficiency are needed to ensure that reduced sulfur compounds and high levels of CO are not emitted. The latter occurs when the incinerator is starved for oxygen.

If the operator measures an excess oxygen level below 1%, the air louvers need to be opened to bring the excess air level to 1% or higher.

If the temperature of the combustion zone drops below 1050°F, the fuel feed rate must be raised (or in some cases the excess oxygen level must be dropped) to ensure a high enough temperature to effect 98% or better combustion efficiency. (The sulfur combustion efficiency is defined here as "one minus the ratio of reduced sulfur concentration to total sulfur concentration in the flue gas".)

It is essential to measure concentrations before any adjustments are made to the SRU. Pre-adjustment concentrations are essential to estimate the tendency for pollutant concentrations to drift. A full description of any adjustments made to the heater during the 24-hour period preceding the monitoring needs to be made part of the test record.

FULL EPA STACK TEST

An initial full stack test based on EPA Methods 1-4 (40 CFR 60, Appendix A) and 6, 7 and 10 is recommended initially for SRUs that have not been tested in the ten years previous to permit issue. Very little is known about these older SRUs. The test should also determine the mass emission rates for NOx, CO, and the combustion efficiency of reduced sulfur compounds (H_2S, COS, CS_2, mercaptans) as well as the SRUs recovery efficiency.

CEM recertification is recommended every three years to ensure the CEM continues to properly measure SO_2 emissions.

REFERENCES

1. Engineering Data Book, Gas Processors Suppliers Association, Tenth Edition, 1994, Chapter 22 (Sulfur Recovery);

2. Code of Federal Regulations, Title 40, Part 60, Subparts J and LLL.